Iowa State Highway Commission
Materials Department Laboratory
Physical Tests Section

Report of R-243

ABRASION of AGGREGATES AS AFFECTED by GRADING

Sept. 21, 1970

IOWA STATE HIGHWAY COMMISSION

MATERIALS DEPARTMENT

Physical Tests Section

Report of R-243

ABRASION OF AGGREGATES AS AFFECTED BY GRADING

September 21, 1970

Ames Laboratory

by

John J. Roland

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1.0 INTRODUCTION

Many specifications for coarse aggregates, that are to be used in highway construction, limit the percentage of wear when tested by AASHO T-96 "Resistance to Abrasion of Coarse Aggregate by Use of the Los Angeles Machine".

This test consists of placing a 5000 gram sample of the aggregate in a "hollow steel cylinder, closed at both ends, having an inside diameter of 28 inches and an inside length of 20 inches. The cylinder - - - shall be mounted in such a manner that it may be rotated with the axis in a horizontal position. - - - A removable steel shelf, projecting radially 3-1/2 inches into the cylinder and extending its full length, shall be mounted along one element of the interior surface of the cylinder."

The abrasive charge consists of steel spheres each weighing between 390 and 445 grams, the number depending upon the grading of the test sample:

Grading	Number of Spheres	Weight of Charge (grams)
A	12	5000 $\pm$ 25
B	11	4584 $\pm$ 25
C	8	3330 $\pm$ 20
D	6	2500 $\pm$ 15

The test sample consists of clean, dry aggregate conforming to one of the gradings shown in Table I. The grading used is the one most representative of the aggregate furnished for the work.

TABLE I - GRADINGS OF TEST SAMPLES

Sieve Size		Weight of Indicated Sizes, g. Grading		
Passing	Retained On	A	B	C
1-1/2 in.	1 in. (1.050)	1250 ± 25	...	...
1 in. (1.050)	3/4 in.	1250 ± 25	...	...
3/4 in.	1/2 in. (0.525)	1250 ± 10	2500 ± 10	...
1/2 in. (0.525)	3/8 in.	1250 ± 10	2500 ± 10	...
3/8 in.	No. 3	...	...	2500 ± 10
No. 3	No. 4	...	...	2500 ± 10
Total		5000 ± 10	5000 ± 10	5000 ± 10

"The test sample and the abrasive charge shall be placed in the Los Angeles abrasion testing machine and the machine rotated at a speed of 30-33 r.p.m. for 500 revolutions". After the required number of revolutions, the contents of the drum are discharged and a determination made of the portion finer than the No. 10 (US No. 12) sieve. The weight of this portion, expressed as a percentage of the original weight of the test sample is reported as the percentage of wear.

It can be seen from Table I that the weight of the abrasive charge is greatest for the coarser grading and progressively decreases as the grading of the test sample becomes finer. It is generally assumed and accepted that for a given aggregate the percentage of wear will be the same regardless of which grading is used provided that the corre-

sponding abrasive charge is also used. Specifications permit either grading A or B on some materials, and for others they do not specify the grading to be used. In at least one instance the grading specified is not representative of the material tested.

Frequently the Laboratory receives aggregate samples that do not contain a particle size distribution which permits the grading A to be used. Consequently a grading B is substituted. The same is true to a lesser extent with a C grading substituted for a B grading.

2.0 PURPOSE

This investigation was undertaken to determine the average percentage of wear test results obtained by using gradings A, B, and C on the same aggregate sample and to verify, if possible, the assumption that the gradings and the corresponding abrasion charges, can be used interchangeably to fulfill the requirements of the specifications.

3.0 MATERIALS

Thirty coarse aggregates representative of those found throughout the state were tested. Six gravel samples were included in this total, the rest were crushed limestone. Sufficient oversize material was obtained from one source to permit crushing in the Laboratory to the three gradings used to compare these test results with the regular production sample from the same source. (Lab. Number AAC9-485 crushed in Laboratory and compared with AAC9-486).

A wide range of resistance to abrasion in the aggregates tested was desirable for this investigation and was obtained

as indicated by the test results.

4.0 LABORATORY PROCEDURE

The weights of the abrasion spheres and the total weights of the charges were checked prior to any testing on this project.

The test procedure used was as described in AASHO T-96 and all apparatus used was in compliance with these specifications (subsequently checked and verified by AASHO Reference Laboratory).

Generally enough material from each source was submitted to run six tests for each of the three gradations, resulting in 18 abrasion tests on each aggregate sample. It was felt that an average of six results on each sample, for each grading, would increase the accuracy of the investigations, and when the particle size distribution of the sample permitted, this number of tests was performed. Otherwise the maximum number of tests possible was run on each sample. A total of 509 test results were reported and are included in the appendix. The averages of these test results are summarized in Tables II, III and IV.

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TABLE II

Average Percent of Wear Using Three Different Gradings on Each of Twenty Different Concrete Limestone Samples

Stone Identification	Grading A	Difference A>B	Grading B	Difference C>B	Grading C
AAC9-507	29.95	1.81	28.14	0.40	28.54
AAC9-505	27.56	2.11	25.45	3.07	28.52
" 497	26.30	1.07	25.23	0.32	25.55
" 531	31.61	1.76	29.85	-0.87	28.98
" 526	44.81	0.42	44.39	-0.09	44.30
" 525	44.63	3.05	41.58	-1.81	39.77
" 524	36.21	-0.99	37.20	0.09	37.29
" 523	45.74	3.28	42.46	-2.60	39.86
" 513	45.78	3.32	42.46	0.75	43.21
" 508	29.95	0.86	29.09	0.36	29.45
" 509	40.43	0.41	40.02	1.98	42.00
" 510	46.09	3.04	43.05	-1.66	41.39
" 496	36.28	2.32	33.96	0.02	33.98
" 491	34.97	1.67	33.30	1.85	35.15
" 487	44.39	0.78	43.61	1.32	44.93
" 486	42.78	2.59	40.19	-1.36	38.83
" 485 *	40.18	4.74	35.44	2.24	37.68
AAC0-1	43.11	2.19	40.92	0.03	40.95
" 8	36.74	1.99	34.75	-0.03	34.72
" 2	24.73	1.66	23.07	1.02	24.09

* Same sample source as 486 but sample prepared by crushing oversize in the Laboratory to obtain the required gradings.

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TABLE III

Average Percent of Wear Using Three Different Gradings on Each of Four Different Surfacing Limestone Samples

Stone Identification	Grading A	Difference A>B	B	Difference C>B	C
AAR9-351	47.97	1.94	46.03	1.27	47.30
AAR9-337	34.27	3.31	30.96	1.84	32.80
AAR9-336	47.20	2.42	44.78	0.38	45.16
AAR9-344	31.58	0.71	30.87	2.45	33.32

TABLE IV

Average Percent of Wear Using Three Different Gradings on Each of Six Different Gravel Samples

Gravel Identification	Grading A	Difference A>B	B	Difference C>B	C
AAG9-297	25.38	0.81	24.57	-1.39	23.18
AAG0-1	22.20	-0.29	22.49	-0.57	21.92
AAG0-7	26.11	5.18	20.93	-2.77	18.16
AAG9-290	25.29	-0.51	25.80	-1.09	24.71
AAG9-296	30.28	3.43	26.85	-3.43	23.42
AAG9-295	23.62	-1.49	25.11	0.48	25.59

5.0 INTERPRETATION OF TEST RESULTS

The crushed limestones, designated for use in portland cement concrete, are tabulated in Table II and represent a wide range of test results on a wide variety of formations found throughout the state and which are commercially available for road construction. This same information for roadstones and gravels is tabulated in Tables III and IV.

The average percentage of wear test results of the three gradings are shown together with a comparison of the A and B and the B and C grading results. No comparison was made between the A and C gradings results, for this substitution would rarely, if ever, be made. The test results shown in Tables II, III and IV are (with a few exceptions) the average of six individual abrasion tests, and summarize a total of 509 abrasion results.

While not a predetermined objective of this investigation, the ability of the laboratory to repeat its results when performing the same test a number of times on the same aggregate is not only of interest but is possibly also necessary in evaluating the differences in percentage of wear obtained when using the three different gradings.

An average spread of 1.44 in the percentage of loss figures was found between the highest and the lowest individual test results obtained on repeat tests using the same aggregate and the same grading. This average spread was computed for 81 sets of tests (75 of six each and six of five each). The maximum spread was 4.24 and the minimum 0.32 percentage points.

Only three sets had a spread greater than 3.00; and 14 more had a spread greater than 2.00. In other words, when the same test was repeated on the same aggregate (same size and source) five or six times, an average of nearly one and one-half percentage points separated the highest abrasion from the lowest, with the remaining three or four intermediate. In 21 percent of the sets the spread was 2.00 or greater, and in 36 percent of the sets the spread was 1.50 or greater.

In evaluating the results in Table II, it is readily apparent that from a total of 20 of these limestones, 19 of the average results for the A grading show a higher percentage of abrasion loss than for the corresponding average loss using the B grading. The average of 19 (AAC9-485 was not used in this average since it introduces another variable) of the differences between the A and the B gradings, taking signs into account, shows this higher loss to be 1.75 percentage points with a maximum of 3.32.

The same table shows that the average percentage of wear for the C grading was higher than the corresponding average for the B grading in 13 of the 20 aggregates tested. The average of 19 of the differences between the average B and C gradings, taking signs into account, shows that the C grading results were 0.15 percentage points higher than the B grading results. The maximum for C grading over the B was 3.07 and the maximum for B grading over the C was 2.60 percentage points.

Table III shows the results obtained when testing four limestone surfacing materials designated as road stones. The average results show that the abrasion loss was higher for the

A grading than for the B grading on all four materials by an average difference of 2.09 percentage points with a maximum difference of 3.31. The average results with the C grading exceed those with the B grading in all four materials with an average difference of 1.48 percentage points and with a maximum difference of 2.45.

In summarizing all the limestones tested it has been shown that the average percentage of wear results obtained when using the A grading exceeds those when the B grading was used in 23 out of 24 materials by an average difference of 1.81 percentage points. Also the average percentage of wear results obtained when using the C grading exceeds those when the B grading was used in 17 out of 24 materials by an average difference of 0.38 percentage points.

A total of six gravels was tested in the same manner as the limestones and the average results tabulated in Table IV. The tests using the A grading showed average results that were higher than the B grading in 3 of the 6 gravels with an average difference of 1.19 percentage points. The average results with the B grading were greater than the C grading in 5 of 6 of the gravels with an average difference of 1.46 percentage points.

The average percent of wear for the stone crushed in the laboratory (AAC9-485) was considerably lower than the average results on the same ledges from the same source when crushed to size for actual production (AAC9-486). The average of the results when using the A grading was 2.60 percentage points lower, B grading, 4.75 lower, and C grading, 1.15 lower.

Since a large amount of block stones and cores are crushed in the laboratory for durability tests including the abrasion test, it is regrettable that this phase of the investigation could not have been persued on more aggregates to establish if the results on this one aggregate are indicative of what could be expected. These results could have carried considerable significance and been of value to the Geologists in evaluating potential sources of aggregates.

6.0 CONCLUSIONS

1. The average percentage of wear results obtained when using the A grading exceeded those when the B grading was used in 23 out of a total of 24 limestones tested by an average difference of 1.81 percentage points.
2. The average percentage of wear results obtained when using the C grading exceeded those when the B grading was used in 17 out of a total of 24 limestones tested by an average difference of 0.38 percentage points.
3. The results obtained on the gravel samples did not follow the same pattern as the limestones. Half of the samples show the average percentage of wear results to be higher when the A grading was used than when the B grading was used. Also the B grading resulted in higher average losses than when the C grading was used on 5 of 6 gravels tested.
4. To eliminate the possibility of a limestone passing a specification by using one grading and failing when using another, it is recommended that, when a percentage of loss is specified, the grading required be also specified rather than left to choice or chance.

5. The ability of the laboratory to repeat its results on duplicate samples to within 1.5 percentage points is shown. This conclusion is based on results of individual tests repeated six times on the same material and grading. On these repeat tests, 64 percent of the sets, of six tests each, had a spread from the highest to the lowest of less than 1.50 percentage points with an average spread of all the sets of 1.44 percentage points.
6. Since large differences in percentages of wear were found between production sample results and laboratory crushed sample results, a continuation of this phase of the investigation might be desirable.

A P P E N D I X

Form 258 Special

Crushed Stone
R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Crushed Limestone Lab. No. AAC9-485

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Malcom Stone Co. Contractor _____

Source Malcom, Ia. SE¼ 4-80-15 Poweshiek Co.

Unit of Material Beds 10C thru 13.

Sampled by Gibbs-Cooper Sender's No. M-18 Date 11/17/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	39.96	34.20	37.80
Test No. 2	40.20	37.76	37.56
Test No. 3	40.38	34.36	

This material recrushed in laboratory before tests were run.

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
– R-243 (2)
Geology

Material Crushed Limestone Lab. No. AAC9-486

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Malcom Stone Co. Contractor _____

Source Malcom SE¼ 4-80-15 Poweshiek Co.

Unit of Material Beds 10C thru 13.

Sampled by Gibbs-Cooper Sender's No. M-19 Date 11/17/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	42.52	40.52	39.20
Test No. 2	43.04	40.06	38.96
Test No. 3	44.04	39.40	38.66
Test No. 4	43.28	40.24	38.04
Test No. 5	41.94	40.92	39.14
Test No. 6	41.88	40.00	39.00

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
— R-243 (2)
Geology

Material Crushed Limestone Lab. No. AAC9-487

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Kaser Constr. Co. Contractor _____

Source Sully, Ia. SE¼ 16-79-17 Jasper Co.

Unit of Material Bed 27

Sampled by Gibbs-Cooper Sender's No. G-45 Date 11/17/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	43.90	43.84	44.90
Test No. 2	44.10	43.00	45.30
Test No. 3	44.96	43.48	45.20
Test No. 4	44.32	44.12	44.32
Test No. 5	44.68	43.60	

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Crushed Stone
R-243 (2)
Geology

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Crushed Stone Lab. No. AAC9-491

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Schildberg's Contractor _____

Source 71 Qr. NW¼ 34-76-36 Cass Co.

Unit of Material Beds 15B-C of K.J.I.'s Gen. Sec.

Sampled by Galiher-Perdue-Popp Sender's No. AL9-283 Date 11/17/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	35.70	33.34	35.24
Test No. 2	34.90	33.64	34.84
Test No. 3	34.80	32.54	35.24
Test No. 4	34.70	33.34	35.12
Test No. 5	34.92	33.50	35.60
Test No. 6	34.80	33.44	34.84

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
R-243 (2)
Geology

Material Coarse Agg. D-57 Lab. No. AAC9-496

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Schildberg Contractor _____

Source SE¼ 5-75-29 Madison Co.

Unit of Material _____

Sampled by Galiher & Perdue Sender's No. AL9-292 Date 11/19/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	37.00	33.32	34.32
Test No. 2	36.12	34.50	33.80
Test No. 3	36.14	34.04	33.52
Test No. 4	35.30	34.04	34.26
Test No. 5	36.34	33.84	33.92
Test No. 6	36.80	34.00	34.04

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Crushed Stone
R-243 (2)
Geology

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS
AMES LABORATORY

Material Coarse Agg. D-57. Lab. No. AAC9-497

Intended Use Concrete Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Schildberg Contractor _____

Source Menlo Qr. SE SE¼ 17-77-31 Adair Co.

Unit of Material Beds 15B-15C, Argentine.

Sampled by Galiher & Perdue Sender's No. GL9-291 Date 11/19/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	25.80	24.98	25.64
Test No. 2	26.20	25.22	25.36
Test No. 3	26.60	25.88	25.80
Test No. 4	26.34	24.92	25.68
Test No. 5	26.46	25.36	25.30
Test No. 6	26.40	25.04	25.52

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
R-243 (2)
Geology

Material 1½" to 1" Stone Lab. No. AAC9-505

Intended Use Research Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Fort Dodge Limestone Co. Contractor _____

Source Ft. Dodge NW¼ SW¼ 24-89-29 Webster Co.

Unit of Material _____

Sampled by D. Yepsen Sender's No. DY-73 Date 12/1/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	27.20	25.06	28.30
Test No. 2	27.34	25.10	28.70
Test No. 3	28.14	26.20	28.44
Test No. 4			28.20
Test No. 5			28.92
Test No. 6			28.58

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
R-243 (2)
Geology

Material Crushed Stone Lab. No. AAC9-507

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer _____ Contractor _____

Source Plower Qr., Linn Co. B6-86-6W.

Unit of Material Otis Member

Sampled by _____ Sender's No. _____ Date _____

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	29.34	28.70	28.44
Test No. 2	30.58	28.32	28.60
Test No. 3	31.30	27.82	28.24
Test No. 4	28.74	27.76	28.94
Test No. 5	29.94	28.10	28.60
Test No. 6	29.80	28.12	28.40

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
— R-243(2)
Geology

Material Crushed Stone Lab. No. AAC9-508

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer _____ Contractor _____

Source McGuire Qr. Cedar Co. 14-80-3W

Unit of Material LeClaire Formation

Sampled by _____ Sender's No. _____ Date 12/3/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	30.32	28.52	29.50
Test No. 2	29.34	28.70	28.34
Test No. 3	30.20	29.42	29.40
Test No. 4	28.80	29.18	29.60
Test No. 5	30.20	29.40	29.80
Test No. 6	30.86	29.34	30.06

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
– R-243(2)
Geology

Material Crushed Stone 1-1/2" - 1" Lab. No. AAC9-509

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer L.A. Light, Inc. Contractor _____

Source Mar Jo Hills Qr. SE 1/4 5-88-3E Dubuque Co.

Unit of Material Taken from stockpile crushed from Stewartville Ledge.

Sampled by O'Brien-McNabb Sender's No. 069-200-205 Date 12/1/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	39.56	40.20	41.90
Test No. 2	39.70	38.80	41.70
Test No. 3	40.58	40.20	42.40
Test No. 4	39.96	40.30	42.32
Test No. 5	42.20	39.64	42.20
Test No. 6	40.56	40.98	41.50

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
— R-243 (2)
Geology

Material Crushed Stone Lab. No. AAC9-510

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer _____ Contractor _____

Source Stone City Qr. 6-84-4 Jones Co.

Unit of Material Anamosa Member

Sampled by _____ Sender's No. _____ Recd. Date 12/3/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	45.70	42.68	41.02
Test No. 2	45.92	43.02	41.66
Test No. 3	45.84	42.64	41.16
Test No. 4	46.36	43.10	41.32
Test No. 5	45.84	43.86	42.12
Test No. 6	46.86	43.00	41.04

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

JK

Crushed Stone
– R-243 (2)
Geology

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Concrete Stone Lab. No. AAC9-513

Intended Use Research Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Weaver Constr. Co. Contractor _____

Source E. of Alden SW 1/4 17-89-21 Hardin Co.

Unit of Material 1" - M-45-69, 3/4" - M-46-69, 1/2" M-47-69, 3/8" - M-49-69, #4 - M-49-69

Sampled by McElvania Sender's No. M-45-69 Date 11/24-12/2/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	45.04	42.34	43.64
Test No. 2	45.98	42.60	43.10
Test No. 3	45.44	42.60	42.72
Test No. 4	47.74	42.60	43.38
Test No. 5	44.70	42.28	
Test No. 6	45.80	42.36	

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Crushed Stone
R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material -1-1/2" +1" Stone Lab. No. AAC9-523

Intended Use _____ Date Reported 2/26/70

County Black Hawk Proj. No. R-243

Producer DeWees Potthoff Contractor _____

Source Raymond, Ia. SE 1/4 36-89-12 Black Hawk Co.

Unit of Material _____

Sampled by C.Schuldt & T.Fairbanks Sender's No. S9-W8 Date 12/5/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	45.46	42.04	39.60
Test No. 2	44.08	42.30	40.70
Test No. 3	46.54	43.60	39.90
Test No. 4	45.52	42.42	39.34
Test No. 5	46.52	41.96	39.68
Test No. 6	46.34		39.96

DISPOSITION:

Signed _____

Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone — R-243(2) Geology

Material Crushed Stone Lab. No. AAC9-524

Intended Use Concrete Date Reported 2/26/70

County _____ Proj. No. R-243

Producer B.L. Anderson Contractor _____

Source Vernon Qr. SW SE 13-84-4 Jones Co.

Unit of Material _____

Sampled by _____ Sender's No. _____ Date _____

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	36.24	37.86	37.32
Test No. 2	36.26	37.68	37.18
Test No. 3	35.10	37.10	36.92
Test No. 4	37.10	36.38	37.56
Test No. 5	35.78	35.96	38.04
Test No. 6	36.80	38.26	36.76

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

JK.

Form 258 Special

Crushed Stone
– R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Washed Limestone -1½" Lab. No. AAC9-525

Intended Use PC Paving Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Roverud Constr. Co. Contractor _____

Source Elkader Qr. NE¼ SW¼ 12-93-5 Clayton Co.

Unit of Material _____

Sampled by Beinke-Grimm Sender's No. C9-580 Date 12/4/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	43.56	41.48	39.90
Test No. 2	45.20	41.28	40.14
Test No. 3	44.96	42.30	39.88
Test No. 4	44.52	41.86	40.14
Test No. 5	44.60	41.06	39.60
Test No. 6	44.94	41.50	38.96

DISPOSITION:

Signed Samuel C. Brown

Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
— R-243 (2)
Geology

Material -1½" Limestone Lab. No. AAC9-526

Intended Use PC Paving Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Kuhlman Constr. Co. Contractor _____

Source Schmidt Qr., 3 Mi. SW of N. Buena Vista SW¼ NE¼ 33-91-1 Clayton Co.

Unit of Material From Bed 4B thru 6E, Stewartville member.

Washed through log.

Sampled by Grimm & Beinke Sender's No. C9-572 Date 12/2/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	44.40	43.92	44.32
Test No. 2	44.48	44.50	43.60
Test No. 3	44.72	44.80	44.20
Test No. 4	45.40	44.08	44.52
Test No. 5	46.08	44.94	45.16
Test No. 6	43.80	44.12	44.00

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Crushed Stone
- R-243 (2)
Geology

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Limestone Lab. No. AAC9-531

Intended Use Research Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Hallett Constr. Co. Contractor _____

Source Gilmore City NE¼ 36-92-31 Poc. Co.

Unit of Material _____

Sampled by Ingertson Sender's No. IS9-38 Date 12/11/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	31.74	30.00	28.58
Test No. 2	32.18	29.80	28.56
Test No. 3	30.72	29.58	28.92
Test No. 4	31.52	30.36	29.20
Test No. 5	31.56	29.76	29.64
Test No. 6	31.96	29.60	

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Form 258 Special

Crushed Stone
— R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material 1-1/2" Crushed Stone Lab. No. AAC0-1

Intended Use _____ Date Reported 2/27/70

County _____ Proj. No. R-243

Producer Kaser Constr. Co. Contractor _____

Source Ollie SE SE 2-74-11 Keokuk Co.

Unit of Material Beds 15 to 19
Burlington Ledge

Sampled by B. Schmidt Sender's No. BS-54-69 Date 11/28/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	43.24	40.48	40.96
Test No. 2	43.20	41.00	41.00
Test No. 3	43.96	40.60	41.12
Test No. 4	43.32	41.04	40.72
Test No. 5	42.12	41.72	
Test No. 6	42.84	40.66	

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

JK.

Form 258 Special

Crushed Stone
— R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material 1-1/2" Crushed Stone Lab. No. AAC0-2

Intended Use Research Date Reported 2/27/70

County _____ Proj. No. R-243

Producer Raid Quarries Corp. Contractor _____

Source Farmington NE 1/4 5-67-8 Van Buren Co.

Unit of Material St. Genevieve Ledge, Beds 2A-3C

Sampled by K. Watson Sender's No. KW-95-69 Date 12/2/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	24.78	22.60	24.06
Test No. 2	24.54	23.14	24.06
Test No. 3	24.82	23.26	24.06
Test No. 4	24.74	22.82	23.68
Test No. 5	24.96	23.28	24.62
Test No. 6	24.56	23.34	24.04

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Crushed Stone
— R-243 (2)
Geology

Material 1-1/2" Crushed Limestone Lab. No. AAC0-8

Intended Use PCC Date Reported 2/27/70

County _____ Proj. No. R-243

Producer Douds Stone, Inc. Contractor _____

Source Douds Field-Douds Mine SE 1/4 25-70-11 Van Buren Co.

Unit of Material Beds 10-15, Spergen Formation. NE Corner of Mine. 5000 tons Dirks & Myers 11/7/57 Sec.

Sampled by L. Robison Sender's No. LR-1-70 Date 12/16-17/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	38.66	34.60	34.70
Test No. 2	36.66	34.52	34.40
Test No. 3	36.66	34.32	35.06
Test No. 4	36.28	35.36	
Test No. 5	36.78	34.86	
Test No. 6	35.40	34.86	

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Road Stone
R-243 (2)
Geology

Material Class D Road Stone Lab. No. AAR9-336

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Gendlers Contractor _____

Source Bedford SW¼ 25-68-34 Taylor Co.

Unit of Material Bed 1, Ervine Creek.

Sampled by Perdue & Galiher Sender's No. AL9-286 Date 11/18/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	48.14	44.74	45.44
Test No. 2	47.08	44.16	45.04
Test No. 3	47.16	44.40	45.40
Test No. 4	46.40	45.80	45.12
Test No. 5	47.52	44.90	44.80
Test No. 6	46.92	44.70	

DISPOSITION:

Signed Samuel C. Brown

Testing Engineer

Road Stone
R-243 (2)
Geology

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Class D Road Stone Lab. No. AAR9-337

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Schildbergs Contractor _____

Source Corning SW¼ 3-71-34 Adams Co.

Unit of Material Beds 3-5, Ervine Creek

Sampled by Galiher & Perdue Sender's No. AL9-285 Date 11/18/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	34.06	31.46	32.60
Test No. 2	35.86	30.44	32.80
Test No. 3	33.82	30.84	33.12
Test No. 4	33.82	31.60	33.14
Test No. 5	33.80	30.20	32.52
Test No. 6		31.20	32.60

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Road Stone
R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Class D Road Rock Lab. No. AAR9-344

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Schildberg Contractor _____

Source Jefferson Qr. SW¼ 8-71-31 Adair Co.

Unit of Material Beds 8-14, Bethany Falls.

Sampled by Perdue & Galiher Sender's No. AL9-290 Date 11/19/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	32.00	30.52	33.62
Test No. 2	31.20	29.88	33.38
Test No. 3	31.38	31.22	33.40
Test No. 4	31.08	31.36	33.80
Test No. 5	32.00	31.22	32.90
Test No. 6	31.84	31.02	32.82

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Road Stone
— R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material: Class D 1" Crushed Stone — Lab. No.: AAR9-346

Intended Use: — Date Reported: 2/26/70

County: — Proj. No.: R-243

Producer: Schildberg's — Contractor:

Source: Atlantic Qr. SE 1/4 6-76-36 Cass Co.

Unit of Material:

Sampled by: Galiher-Perdue — Sender's No.: AL9-310 — Date: 12/1/69

Sample discarded - no 1-1/2" - 1" material.

DISPOSITION:

Signed: Bernard C. Brown
Testing Engineer

J.K.

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Road Stone — R-243 (2) Geology

Material Graded Stone Base Lab. No. AAR9-351

Intended Use Research Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Weaver Constr. Co. Contractor _____

Source E.of Alden SW 1/4 17-89-21 Hardin Co.

Unit of Material 1" = M-50-69, 3/4" - M-51-69, 1/2" - M-52-69, 3/8" - M-53-69, #4 - M-54-69

Sampled by McElvania Sender's No. M-50-54-69 Date 11/27-12/3/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	48.48	45.92	46.80
Test No. 2	48.24	46.26	47.86
Test No. 3	47.64	46.80	46.80
Test No. 4	47.80	45.88	47.00
Test No. 5	47.28	45.32	47.20
Test No. 6	48.40	46.00	48.12

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

Gravel
R-243 (2)
Geology

TEST REPORT — MISCELLANEOUS MATERIALS
AMES LABORATORY

Material Gravel Lab. No. AAG9-290

Intended Use Research Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Hallett Constr. Co. Contractor _____

Source W. Boone - Sturtz Pit SW¼ SW¼ 36-84-27 Boone Co.

Unit of Material _____

Sampled by B.E. Stoline Sender's No. BS1/AG-12 Date 11/20/69

	% Of Wear, LA Abrasion Grading		
	A	B	C
Test No. 1	26.14	26.16	24.96
Test No. 2	24.72	25.40	24.42
Test No. 3	24.80	25.20	24.84
Test No. 4	25.90	26.34	24.40
Test No. 5	24.80	26.08	25.06
Test No. 6	25.40	25.64	24.60

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Gravel
— R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Gravel Lab. No. AAG9-295

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer _____ Contractor _____

Source Peters Pit 31-90-46 Plymouth Co.

Unit of Material _____

Sampled by _____ Sender's No. _____ Date Recd. 12/3/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	23.92	24.28	25.84
Test No. 2	24.80	25.60	25.52
Test No. 3	22.48	25.50	26.32
Test No. 4	23.84	25.40	25.04
Test No. 5	23.48	24.72	25.00
Test No. 6	23.20	25.16	25.82

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

JJC

Form 258 Special

Gravel
– R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Gravel Lab. No. AAG9-296

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Conc. Matls. Contractor _____

Source Baird Pit, NW 1/4 2-82-7 Linn Co.

Unit of Material _____

Sampled by _____ Sender's No. _____ Date Recd. 12/3/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	30.68	26.72	23.38
Test No. 2	29.90	26.44	23.76
Test No. 3	31.28	26.46	24.28
Test No. 4	28.52	27.12	22.90
Test No. 5	30.40	27.12	23.02
Test No. 6	30.88	27.24	23.20

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Gravel
R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material -1-1/2" - +1" Gravel Lab. No. AAG9-297

Intended Use Research Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Clear Lake Sand & Gravel Contractor _____

Source Clear Lake S 1/2 8-96-21 Cerro Gordo Co.

Unit of Material -1½" to +1" Matl.

Stockpile

Sampled by Behmer-Holmlund Sender's No. C9-575 Date 12/4/69

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	25.80	25.48	23.50
Test No. 2	24.86	25.34	22.66
Test No. 3	24.28	23.58	23.72
Test No. 4	25.66	24.52	23.16
Test No. 5	25.06	24.20	23.12
Test No. 6	26.60	24.32	22.90

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer

Form 258 Special

Gravel
– R-243 (2)
Geology

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

Material Gravel Lab. No. AAG0-1

Intended Use _____ Date Reported 2/26/70

County _____ Proj. No. R-243

Producer Hallett Contractor _____

Source Sacton 8-86-36 Sac Co.

Unit of Material _____

Sampled by _____ Sender's No. _____ Date Recd. 1/28/70

	% of Wear, Los Angeles Abrasion, Grading		
	A	B	C
Test No. 1	22.60	23.16	22.00
Test No. 2	21.98	21.64	22.00
Test No. 3	22.20	21.58	21.60
Test No. 4	21.34	22.68	21.92
Test No. 5	21.80	23.20	21.98
Test No. 6	23.28	22.68	22.00

DISPOSITION:

Signed Bernard C. Brown

Testing Engineer

FK.

Form 258 Special

Iowa State Highway Commission

MATERIALS DEPARTMENT

TEST REPORT — MISCELLANEOUS MATERIALS

AMES LABORATORY

— R-243 (2)
Geology

Material Gravel Lab. No. AAGO-7

Intended Use PCC Date Reported 3/3/70

County _____ Proj. No. R-243

Producer Acme F&M Co. Contractor _____

Source Muscatine W 1/2 22-76-2W Muscatine Co.

Unit of Material _____

Sampled by Stan Smith Sender's No. SS-2-70 Date 2/9/70

	% Wear, Los Angeles Abrasion, Grading A	B	C
Test No. 1	23.76	20.84	18.08
Test No. 2	25.80	21.10	18.20
Test No. 3	28.00	21.90	17.52
Test No. 4	25.80	20.92	18.46
Test No. 5	27.94	21.46	18.96
Test No. 6	25.34	19.34	17.72

DISPOSITION:

Signed Bernard C. Brown
Testing Engineer